SP 222 Homework Chapter 32 Due APR 2000 Name _____

3 ·· A parallel-plate capacitor in air has circular plates of radius 2.3 cm separated by 1.1 mm. Charge is flowing onto the upper plate and off the lower plate at a rate of 5 A. Show that at a distance r from the axis of the plates the magnetic field between the plates is given by $B = (1.89\times10^{-3}\ \text{T/m})r$ if r is less than the radius of the plates.

4 ·· (*a*) Show that for a parallel-plate capacitor the displacement current is given by $I_d = C\,dV/dt$, where C is the capacitance and V the voltage across the capacitor. (*b*) A parallel plate capacitor C = 5 nF is connected to an emf $\mathcal{E} = \mathcal{E}_0 \cos \omega t$, where $\mathcal{E}_0$ = 3 V and $\omega = 500\pi$. Find the displacement current between the plates as a function of time. Neglect any resistance in the circuit.

12 · Which waves have greater frequencies, light waves or X rays?

13* · Are the frequencies of ultraviolet radiation greater or less than those of infrared radiation?

14 · What kind of waves have wavelengths of the order of a few meters?

19 · A transmitter uses a loop antenna with the loop in the horizontal plane. What should be the orientation of an electric dipole antenna at the receiver for optimum signal reception?

21* ·· The intensity of radiation from an electric dipole is proportional to $(\sin^2 \theta)/r^2$, where θ is the angle between the electric dipole moment and the position vector ***r***. A radiating electric dipole lies along the *z* axis (its dipole moment is in the *z* direction). Let I_1 be the intensity of the radiation at a distance $r = 10$ m and at angle $\theta = 90°$. (*a*) At what angle is the intensity at $r = 5$ m equal to I_1? (*b*) At what distance is the intensity equal to I_1 at $\theta = 45°$?

31 ·· (*a*) An electromagnetic wave of intensity 200 W/m^2 is incident normally on a rectangular black card with sides of 20 cm and 30 cm that absorbs all the radiation. Find the force exerted on the card by the radiation. (*b*) Find the force exerted by the same wave if the card reflects all the radiation incident on it.

39 •• The electric field of an electromagnetic wave oscillates in the *y* direction and the Poynting vector is given by $\vec{S}(x,t) = S_0 \cos^2(kx - \omega t)\hat{\boldsymbol{i}}$, where S_0 = 100 W/m^2, k = 10 m^{-1}, and ω = 3 x 10^9 s^{-1}. (*a*) What is the direction of propagation of the wave? (*b*) Find the wavelength and the frequency. (*c*) Find the electric and magnetic fields.

41* •• A 10- by 15-cm card has a mass of 2 g and is perfectly reflecting. The card hangs in a vertical plane and is free to rotate about a horizontal axis through the top edge. The card is illuminated uniformly by an intense light that causes the card to make an angle of 1° with the vertical. Find the intensity of the light.

49* · Use the known values of ε_0 and μ_0 in SI units to compute $c = 1/\sqrt{\varepsilon_0 \mu_0}$ and show that it is approximately 3×10^8 m/s.

51 · True or false:

(*a*) Maxwell's equations apply only to fields that are constant over time.

(*b*) The wave equation can be derived from Maxwell's equations.

(*c*) Electromagnetic waves are transverse waves.

(*d*) In an electromagnetic wave in free space, the electric and magnetic fields are in phase.

(*e*) In an electromagnetic wave in free space, the electric and magnetic field vectors ***E*** and ***B*** are equal in magnitude.

(*f*) In an electromagnetic wave in free space, the electric and magnetic energy densities are equal.

56 ·· The electric field from a radio station some distance from the transmitter is given by $E = (10^{-4}\ \text{N/C})\cos\omega t$, where $\omega = 10^6\ \text{s}^{-1}$. (*a*) What voltage is picked up on a 50-cm wire oriented along the electric field direction? (*b*) What voltage can be induced in a loop of radius 20 cm?

61* ·· At the surface of the earth there is an approximate average solar flux of 0.75 kW/m^2. A family wishes to construct a solar energy conversion system to power their home. If the conversion system is 30% efficient and the family needs a maximum of 25 kW, what effective surface area is needed for perfectly absorbing collectors?